CRIN

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FICHA TECNICA DE:

RADIO APRISA 4RF

4RF

Aprisa SR

Product Description

Compliance General

The Aprisa SR digital radio predominantly operates within frequency bands that require a site license be issued by the radio regulatory authority with jurisdiction over the territory in which the equipment is being operated.

It is the responsibility of the user, before operating the equipment, to ensure that where required the appropriate license has been granted and all conditions attendant to that license have been met.

Changes or modifications not approved by the party responsible for compliance could void the user's authority to operate the equipment.

Equipment authorizations sought by 4RF Communications are based on the Aprisa SR radio equipment being installed at a fixed location and operated in point-to-multipoint mode within the environmental profile defined by EN 300 019, Class 3.4. Operation outside these criteria may invalidate the authorizations and / or license conditions.

The term "Radio" with reference to the Aprisa SR User Manual, is a generic term for one end station of a point-to-multipoint Aprisa SR network and does not confer any rights to connect to any public network or to operate the equipment within any territory.

Compliance ETSI

The Aprisa SR radio is designed to comply with the European Telecommunications Standards Institute (ETSI) specifications as follows:

Radio performance	EN 300 113-2
EMC	EN 301 489 Parts 1 & 5
Environmental	EN 300 019, Class 3.4
Safety	EN 60950-1:2006

Frequency band	Channel size	Power input	Notified body
136-174 MHz	12.5 kHz	12 VDC	
400-470 MHz	12.5 kHz	12 VDC	

RF Exposure Warning

WARNING:

The installer and / or user of Aprisa SR radios shall ensure that a separation distance as given in the following table is maintained between the main axis of the terminal's antenna and the body of the user or nearby persons.

Minimum separation distances given are based on the maximum values of the following methodologies:

1. Maximum Permissible Exposure non-occupational limit (B or general public) of 47 CFR 1.1310 and the methodology of FCC's OST/OET Bulletin number 65.
2. Reference levels as given in Annex III, European Directive on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC). These distances will ensure indirect compliance with the requirements of EN 50385:2002.

Frequency (MHz)	Maximum Power (dBm)	Maximum Antenna Gain (dBi)	Minimum Separation Distance (m)
136	+ 37	15	2.5
174	+ 37	15	2.5
330	+ 37	15	2.5
400	+ 37	15	2.5
470	+ 37	15	2.3
520	+ 37	15	2.2
850	+ 37	28	7.7
960	+ 37	28	7.2

Contents

1. Introduction 7

The 4RF Aprisa SR Radio 7
Product Overview 8
Network Coverage and Capacity 8
Remote Messaging 8
Repeater Messaging 9
Product Features 10
Functions 10
Performance 10
Usability 10
Architecture 11
Security 12
Interfaces 13
Antenna Interface 13
Ethernet Interface 13
USB Interfaces 13
RS-232 Interface 13
Product Options 14
Dual Antenna 14
Mounting 15
DIN Rail Mounting 15
Rack Shelf Mounting 16
Wall Mounting 17

2. Specifications 18

RF Specifications 18
ETSI Compliant 18
Frequency Bands 18
Channel Sizes 18
Product Range 18
Transmitter 19
Receiver 19
Modem 20
Data Payload Security 20
Interface Specifications 21
Ethernet Interface 21
RS-232 Asynchronous Interface 21
Power Specifications 22
Power Supply 22
Power Consumption 22
Power Dissipation 22
General Specifications 23
Environmental 23
Mechanical 23
ETSI compliance 23

3. Management 25

SuperVisor 25
Viewing the Aprisa SR Terminal Settings 25
Configuring the Aprisa SR Terminal Details 26
Configuring the Aprisa SR RF Network Details 26
Configuring the Aprisa SR Radio Settings 27
Command Line Interface 28
Management Display Panel 29
LED Display Panel 30
Normal Operation 30
Software Upgrade 30
Test Mode 31

4. Applications 32

Basic point-to-multipoint application 32
Advanced point-to-multipoint application with repeater 33
Multi-interface point-to-multipoint application 34

5. Architecture 35

Product Description 35
Frame 35
MAC Header 35
Network Header 36
Payload 36
Auxillary Frame 36
Physical Layer 37
Data Link Layer / MAC layer 37
Channel Access 37
Hop by Hop Transmission 37
Network Layer 38
Packet Routing 38
Product Operation 39
Carrier Sense Disabled 39
Carrier Sense Enabled 40
Product Architecture 43
Radio Block Diagram 44
Modem Block Diagram 44

6. Contact Us 45

1. Introduction

The 4RF Aprisa SR Radio

The 4RF Aprisa SR is a point-to-multipoint digital radio providing secure narrowband wireless data connectivity for SCADA, infrastructure and telemetry applications.

The radios carry a combination of serial packet data and Ethernet data between the Base Station, Repeater Stations and Remote Stations.

The Aprisa SR is configurable as a point-to-multipoint Base Station, a Remote Station or a Repeater Station.

Product Overview

Network Coverage and Capacity

In a simple point-to-multipoint network, an Aprisa SR, configured as a base station, will communicate with multiple remote units in a given coverage area. With a link range of up to 60 km a typical deployment will have 30 – 50 remote stations attached to the base station. However, geographic features, such as hills, mountains, trees and foliage, or other path obstructions, such as buildings, tend to limit radio coverage. Additionally, geography may reduce network capacity at the edge of the network where errors may occur and require retransmission. However, the Aprisa SR uses Forward Error Correction (FEC) which greatly improves the sensitivity performance of the radio resulting in less retries and minimal reduction in capacity.

Ultimately, the overall performance of any specific network will be defined by a range of factors including the geographic location, the number of remote stations in the base station coverage area and the traffic profile across the network.). Effective network design will distribute the total number of remote stations across the available base stations to ensure optimal geographic coverage and network capacity.

Remote Messaging

Base stations are fitted with omni-directional antennas and the remote stations use directional Yagi antennas for higher gain. On start-up the base station transmits a registration message which is recognised by the remote stations which respond with their own registration message. This allows the base station to record the details of all the remote stations active in the network.

There are two message types in the Aprisa SR network, **broadcast** messages and **unicast** messages. Broadcast messages are transmitted by the base station to the remote stations and **unicast** messages are transmitted by the remote station to the base station.

All the remote stations, within the coverage area, will receive the messages broadcast from the base station, but only the radio the message is intended for will action the message. Only the base station can receive the unicast messages transmitted from the remote station. Unicast messages are ignored by other remote stations which may be able to receive them. The Aprisa SR network is not designed for remote stations to communicate with other remote stations.

Repeater Messaging

The Aprisa SR uses a routed protocol throughout the network whereby messages contain source and destination addresses. Upon registration, the radios populate an internal neighbor table to identify the radios in the network. The remote stations will register with a base station, or a repeater, and the repeater registers with a base station. In networks with a repeater, the repeater must register with the base station before the remotes can register with the repeater.

Additionally, all messages contain a 'message type' field in the header and messages are designated as either a 'broadcast' message, originating from a base station, or a 'unicast' message, originating from a remote station.

In a network with a repeater, or multiple repeaters, the base station broadcasts a message which contains a message type, a source address and a destination address. The repeater receives the message and recognizes it is a broadcast message, from the message type and source address and re-broadcasts the message across the network. All remote stations in the coverage area will receive the message but only the radio with the destination address will act upon the message.

Similarly, the remote station will send a unicast message which contains a message type (unicast) a source address and a destination address (the base station). The repeater will receive this message; recognize the message type and source address and forward it to the destination address.

It is this methodology which prevents repeater-repeater loops. If there is repeater (A) which, in some circumstances, is able to pick up the RF signal from another repeater (B), it will not forward the message as it will only forward broadcast messages from the base station (recognised by the source address). For unicast messages the repeater (A) will recognize that the message (from repeater (B)) is not from a remote with which it has an association and similarly ignore the message.

Product Features

Functions

- Point-to-Point (PTP) or Point-to-Multipoint (PMP) operation half duplex
- Licensed frequency bands:

  VHF 136-174 MHz
  UHF 330-400 MHz †
  UHF 400-470 MHz
  UHF 450-520 MHz †
  UHF 850-960 MHz †

- Channel sizes:

  6.25 kHz †
  12.5 kHz
  25 kHz †

- Typical deployment of 30 Remote Stations from one Base Station with a practical limit of a few hundred Remote Stations.
- Dual antenna option for external duplexers or filters (half duplex operation)
- Ethernet data interface *plus* RS-232 asynchronous data interface.
- Data encryption and authentication.
- Complies with international standards, including ETSI RF, EMC, safety and environmental standards.

† Future Product Release

Performance

- Long distance operation (typically 30 km radius).
- High transmit power.
- Low noise receiver.
- Forward Error Correction.
- Electronic tuning over the frequency band.
- Thermal management for high power over a wide temperature range.

Usability

- Configuration / diagnostics via front panel Management Port USB interface, Ethernet interface.
- Remote station configuration / diagnostics over the radio link.
- LED display for on-site diagnostics.
- Optional management display for advanced on-site configuration.
- Firmware upgrade and diagnostic reporting via the Host Port USB flash drive.
- Simple installation with integrated mounting holes for wall, DIN rail and rack shelf mounting.

Architecture

The Aprisa SR Architecture is based around a layered TCP/IP protocol stack:

- Physical
  Proprietary wireless
  Standard RS-232 and Ethernet
- Link
  Proprietary wireless (channel access, ARQ, segmentation)
  Standard Ethernet
- Network
  Standard IP
  Proprietary automatic radio routing table population algorithm
- Transport
  Standard TCP, UDP
- Application
  Proprietary management application software

Security

The Aprisa SR provides security features to implement the key recommendations for industrial control systems. The security provided builds upon the best in class from multiple standards bodies, including:

- IEC/TR 62443 (TC65) "Industrial Communications Networks – Network and System Security".
- IEC/TS 62351 (TC57) "Power System Control and Associated Communications – Data and Communication Security".

It also adds additional security features through Layer 3 network integration.

The security features implemented are:

- Licensed radio spectrum protects against interference.
- Proprietary physical layer protocol and modified MAC layer protocol based on standardized IEEE 802.15.4.
- Data payload security:

  CCM Counter with CBC-MAC integrity (NIST special publication 800-38C).
- Data encryption:

  Counter Mode Encryption (CTR) using Advanced Encryption Standard (AES).
- Data authentication:

  Cipher Block Chaining Message Authentication Code (CBC-MAC) using Advanced Encryption Standard (AES).
- Secured management interface protects configuration.
- Address filtering enables traffic source authorization †.
- Distributed Layer 3 firewall protects remote nodes †.
- Segregated traffic flow enables node isolation, with VLAN and Layer 3 subnets †.

† Future Product Release

Interfaces

Antenna Interface

Single Antenna Option

- 1 x TNC, 50 ohm, female connector

Dual Antenna Option

- 2 x TNC, 50 ohm, female connectors

Ethernet Interface

- 2 x ports 10/100 base-T Ethernet layer 2 switch using RJ-45.

  Used for Ethernet user traffic and product management.

USB Interfaces

- 1 x Management Port using USB micro type B connector.

  Used for product configuration with the Command Line Interface (CLI).

- 1 x Host Port using USB standard type A connector.

  Used for software upgrade and diagnostic reporting.

RS-232 Interface

- 1x RS-232 asynchronous port using RJ-45 connector.

  Used for RS-232 async user traffic only.

Product Options

Dual Antenna

The standard Aprisa SR uses a one or two frequency ½ duplex transmission mode which eliminates the need for a duplexer. However, a Dual Antenna option is available for separate transmit and receive antenna connection to support external duplexers or filters. The transmission remains half duplex.

Antenna Option	Part Number
Single Antenna	APSR-N400-012-SO-12-ETAA
Dual Antenna	APSR-N400-012-DO-12-ETAA

Mounting

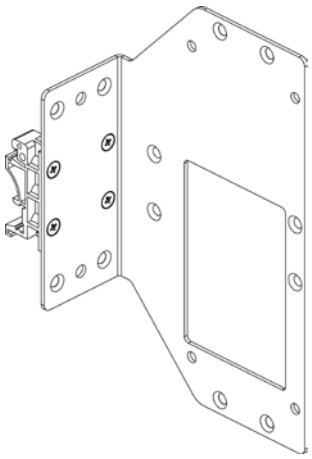
The Aprisa SR has four threaded holes (M4) in the enclosure base and two holes (5.2 mm) through the enclosure for mounting.

Mounting options include:

- DIN rail mounting with the Aprisa SR DIN Rail Mounting Bracket
- Rack shelf mounting
- Wall mounting
- Outdoor enclosure mounting

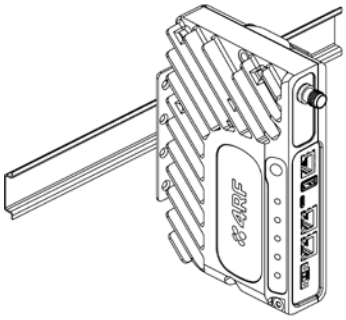
DIN Rail Mounting

The Aprisa SR has an optional accessory part '4RF Aprisa SR Acc, Mounting, Bracket, DIN Rail'.

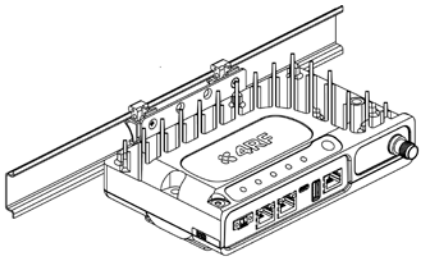


The Aprisa SR DIN rail mounting bracket can be mounted in four positions on a horizontal DIN rail:

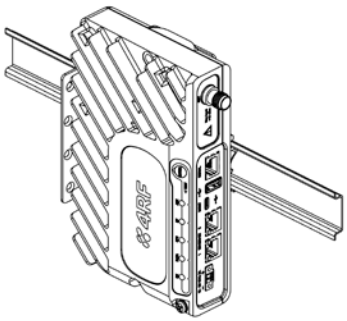
- Vertical Mount (vertical enclosure perpendicular to the mount)
- Horizontal Mount (horizontal enclosure perpendicular to the mount).
- Flat Vertical Mount (vertical enclosure parallel to the mount)
- Flat Horizontal Mount (horizontal enclosure parallel to the mount)



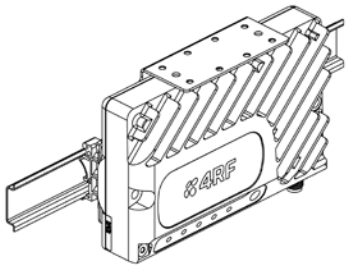
Vertical Mount



Horizontal Mount



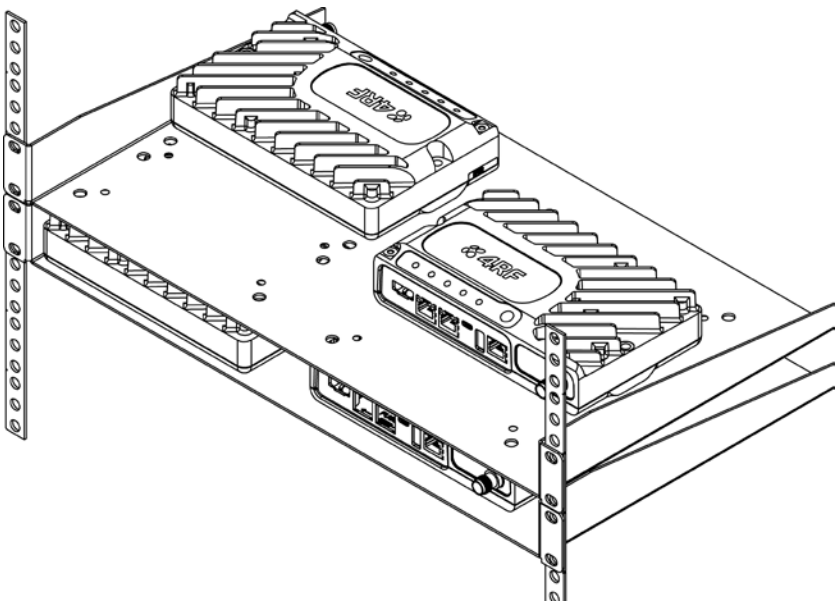
Flat Vertical Mount



Flat Horizontal Mount

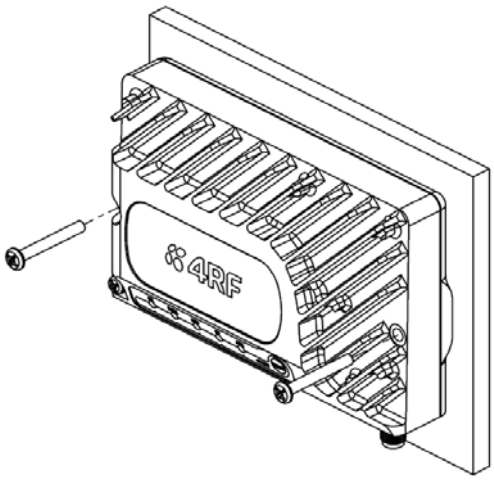
Rack Shelf Mounting

The Aprisa SR can be mounted on a rack mount shelf using the four M4 threaded holes in the Aprisa SR enclosure base. The following picture shows Aprisa SR mounted on 1 RU rack mounted shelves.



Wall Mounting

The Aprisa SR can be mounted on a wall using the two holes through the enclosure (5.2 mm diameter). Typically, M5 screws longer than 35 mm would be used.



2. Specifications

RF Specifications

ETSI Compliant

Frequency Bands

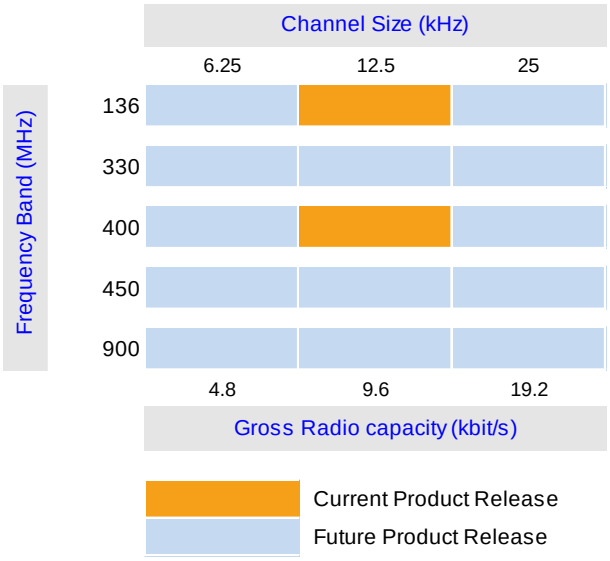
Broadcast Band	Frequency Band	Frequency Tuning Range	Synthesizer Step Size
VHF	136 MHz	136-174 MHz	3.125 kHz
UHF	330 MHz †	330-400 MHz	6.250 kHz
UHF	400 MHz	400-470 MHz	6.250 kHz
UHF	450 MHz †	450-520 MHz	6.250 kHz
UHF	900 MHz †	850-960 MHz	6.250 kHz

Channel Sizes

Channel Size	Gross Radio Capacity
6.25 kHz †	4.8 kbit/s
12.5 kHz	9.6 kbit/s
25 kHz †	19.2 kbit/s

† Future Product Release

Product Range



Transmitter

Power output	0.1 to 5.0 W (+20 to +37 dBm, in 1 dB steps)
Adjacent channel power	< - 60 dBC
Transient adjacent channel power	< - 50 dBC
Spurious emissions	< - 37 dBm
Attack time	< 1.5 ms
Release time	< 1.5 ms
Data turnaround time	< 10 ms
Frequency stability	± 1 ppm
Frequency aging	< 1 ppm / annum
Synthesizer lock time	< 1.5 ms (5 MHz step)

Receiver

		6.25 kHz †	12.5 kHz	25 kHz †
Receiver Sensitivity	BER < 10^{-2}	–119 dBm	–117 dBm	–114 dBm
	BER < 10^{-3}		–114 dBm	
	BER < 10^{-6}		–110 dBm	
Adjacent Selectivity		> 60 dB	> 60 dB	> 70 dB
Co-channel rejection			> –12 dB	

Intermodulation response rejection	> 70 dB
Blocking or desensitization	> 84 dB
Spurious response rejection	> 75 dB

Modem

Modulation	4-CPFSK
Forward Error Correction	¾ Trellis code

Data Payload Security

Data payload security	CCM* Counter with CBC-MAC
Data encryption	Counter Mode Encryption (CTR) using Advanced Encryption Standard (AES) 128, 192 or 256
Data authentication	Cipher Block Chaining Message Authentication Code (CBC-MAC) using Advanced Encryption Standard (AES) 128, 192 or 256

† Future Product Release

Interface Specifications

Ethernet Interface

The Aprisa SR radio features an integrated 10Base-T/100Base-TX layer-2 Ethernet switch.

To simplify network setup, each port supports auto-negotiation and auto-sensing MDI/MDIX. Operators can select from the following preset modes:

- Auto negotiate
- 10Base-T half or full duplex
- 100Base-TX half or full duplex

The switch is IEEE 802.3-compatible. It passes VLAN tagged traffic.

General	Interface	RJ-45 x 2 (Integrated 2-port switch)
	Cabling	CAT-5 UTP, supports auto MDIX (Standard Ethernet)
	Maximum line length	100 metres on cat-5 or better
	Bandwidth allocation	The Ethernet capacity maximum is determined by the available radio link capacity.
	Maximum transmission unit	Option setting of 1522 or 1536 octets
	Address table size	1024 MAC addresses
	Ethernet mode	10Base-T or 100Base-TX Full duplex or half duplex (Auto-negotiating and auto-sensing)
Diagnostics	Left Green LED	Off: no Ethernet signal received On: Ethernet signal received
	Right Green LED	Off: Indicates no data traffic present on the interface Flashing: Indicates data traffic present on the interface

RS-232 Asynchronous Interface

The Aprisa SR radio's ITU-T V.24 compliant RS-232 interface is configured as a Cisco® pinout DCE. The interface terminates to a DTE using a straight-through cable or to a DCE with a crossover cable (null modem).

The interface uses two handshaking control lines between the DTE and the DCE.

General	Interface	ITU-T V.24 / EIA/TIA RS-232E
	Interface direction	DCE only
	Maximum line length	10 metres
Async parameters	Standard mode data bits	7 or 8 bits
	Standard mode parity	Configurable for None, Even or Odd
	Standard mode stop bits	1 or 2 bits
	Interface baud rates	300, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 bit/s
Control signals	DCE to DTE	CTS, RTS, DSR, DTR

Power Specifications

Power Supply

Nominal voltage	+13.8 VDC (negative earth)
Input voltage range	+10 to +30 VDC
Maximum power input	30 W
Connector	Phoenix Contact 4 pin male screw fitting MC 1.5/ 4-GF-3.5

Power Consumption

Mode	Power Consumption
Transmit / Receive	< 22.5 W for 5W transmit power
	< 15.0 W for 1W transmit power
Receive only	< 6 W full Ethernet traffic activity
	< 4.5 W no Ethernet traffic activity

Power Dissipation

Transmit Power	Power Dissipation
1W transmit power	< 14.0 W
5W transmit power	< 17.5 W

General Specifications

Environmental

Operating temperature range	-40 to +70˚ C
Storage temperature range	-40 to +80˚ C
Operating humidity	Maximum 95% non-condensing
Acoustic noise emission	No audible noise emission

Mechanical

Dimensions	Width 177 mm Depth 110 mm (126 mm with TNC connector) Height 41.5 mm
Weight	720 g
Colour	Matt black
Mounting	Wall (2 x M5 screws) Rack shelf (2 x M4 screws) DIN rail bracket

ETSI compliance

Radio	EN 300 113
EMI / EMC	EN 301 489 Parts 1 & 5
Safety	EN 60950
Environmental	ETS 300 019 Class 3.4

3. Management

SuperVisor

The Aprisa SR contains an embedded web server application (SuperVisor) to enable element management with any major web browser (such as Mozilla Firefox, Microsoft® Internet Explorer).

SuperVisor enables operators to configure and manage the Aprisa SR base station radio and repeater / remote station radios over the radio link.

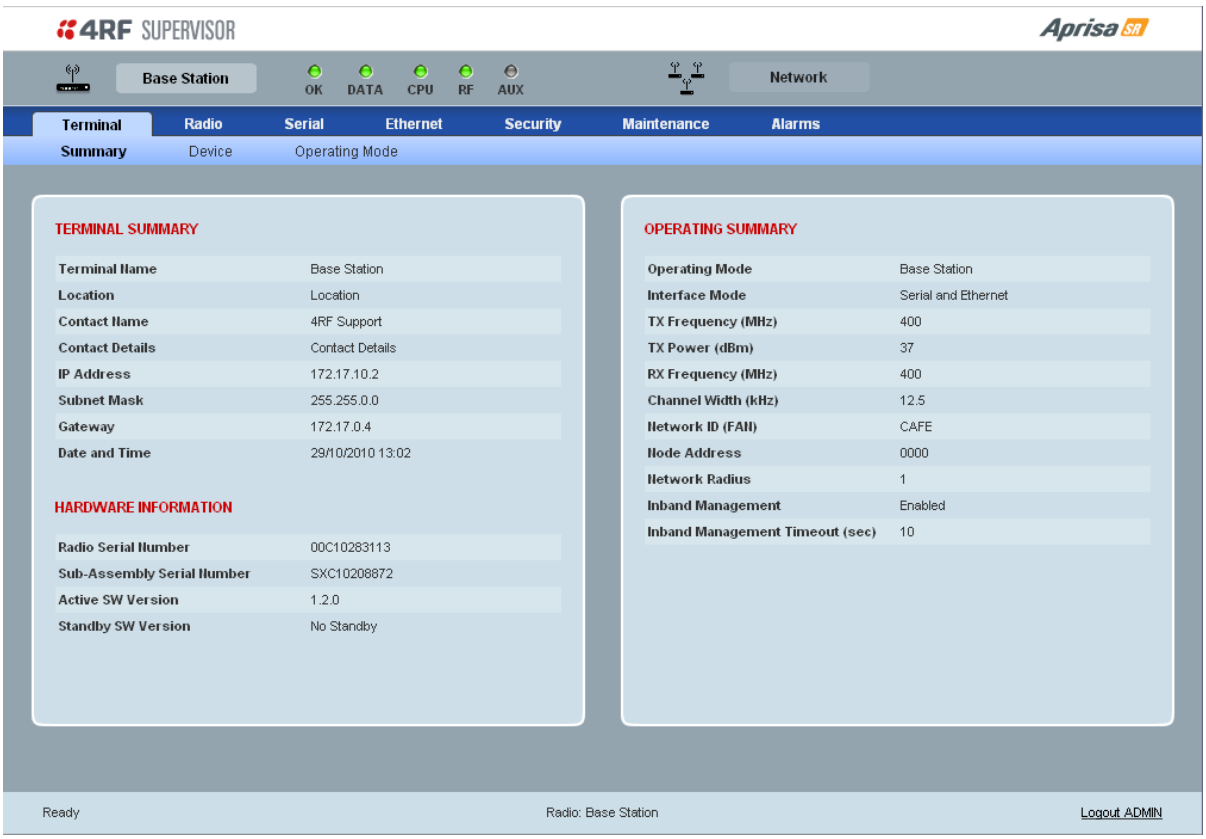
The key features of SuperVisor are:

- View and set standard radio configuration parameters, including frequencies, transmit power, channel access, serial, Ethernet and USB port settings
- Set terminal operating mode, whether base station, remote station or repeater station
- Set and view security parameters, including keys
- Display performance and alarm information, including RSSI, alarm status, time-stamped events, alarm parameters

The following are four examples of SuperVisor screens:

Viewing the Aprisa SR Terminal Settings

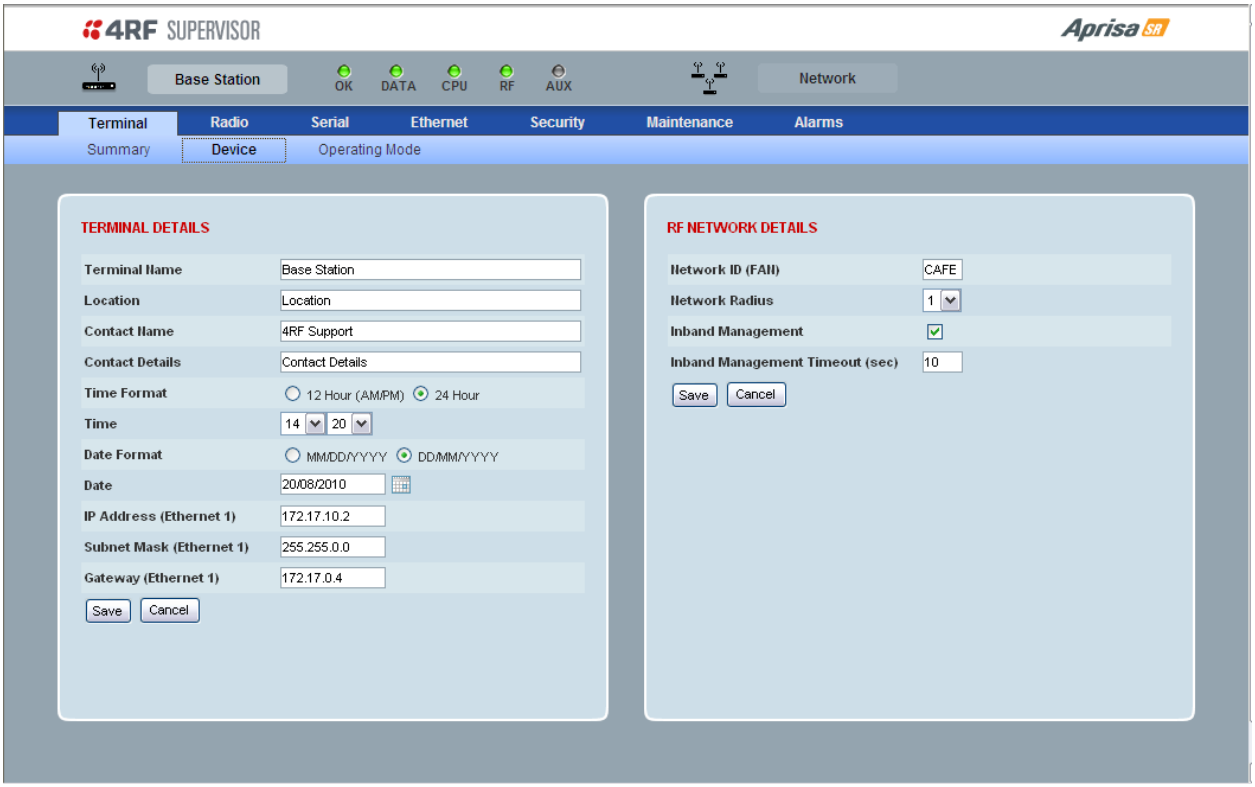
The SuperVisor software enables operators to view the terminal settings:



Configuring the Aprisa SR Terminal Details

The SuperVisor software enables operators to set the terminal details including:

- Terminal Name
- Location
- Contact Name
- Contact Details
- Current Date
- Ethernet port IP Address / Subnet Mask / Gateway Address



Configuring the Aprisa SR RF Network Details

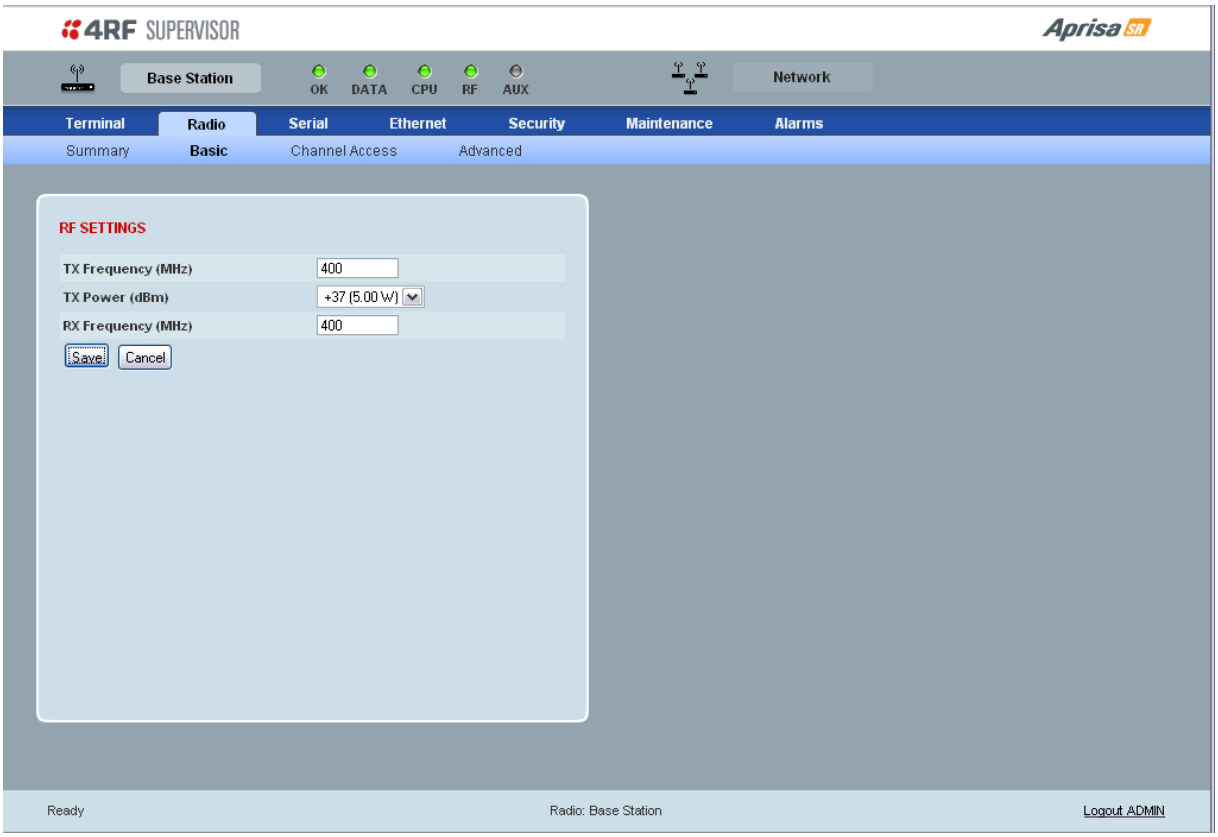
The SuperVisor software enables operators to set the RF Network Details including:

- Network ID (FAN) (Field Area Network)
  - four hex chars
  - network ID of this base station node and its remote nodes
- Node Address
  - four hex chars
  - base station = 0000
  - remote stations = 0001 to FFFD
- Network Radius
  - sets the maximum number of hops in this network
- Inband Management
  - enables Inband Management of Remotes / Repeaters
- Inband Management Timeout (sec)
  - sets the Inband Management timeout period

Configuring the Aprisa SR Radio Settings

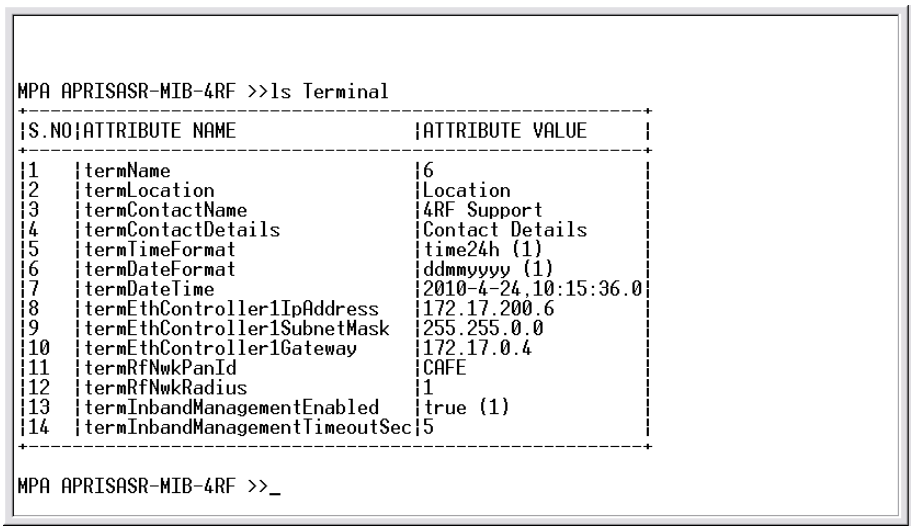
The SuperVisor software enables operators to set the radio settings including:

- Transmit frequency MHz
- Transmit power dBm / watts
- Receive frequency MHz
- Channel type – link capacity vs channel size



Command Line Interface

The Aprisa SR has a Command Line Interface (CLI) which provides basic product setup and configuration. This interface can be accessed via an Ethernet Port (RJ-45) or the Management Port (USB micro type B). The Terminal menu is shown in the following picture:



```
MPA APRISASR-MIB-4RF >>ls Terminal
+-----------------------------------------------------------+
|S.NO|ATTRIBUTE NAME                |ATTRIBUTE VALUE      |
+-----------------------------------------------------------+
|1   |termName                      |6                    |
|2   |termLocation                  |Location             |
|3   |termContactName               |4RF Support          |
|4   |termContactDetails            |Contact Details      |
|5   |termTimeFormat                |time24h (1)          |
|6   |termDateFormat                |ddmmyyyy (1)         |
|7   |termDateTime                  |2010-4-24,10:15:36.0 |
|8   |termEthController1IpAddress   |172.17.200.6         |
|9   |termEthController1SubnetMask  |255.255.0.0          |
|10  |termEthController1Gateway     |172.17.0.4           |
|11  |termRfNwkPanId                |CAFE                 |
|12  |termRfNwkRadius               |1                    |
|13  |termInbandManagementEnabled   |true (1)             |
|14  |termInbandManagementTimeoutSec|5                    |
+-----------------------------------------------------------+

MPA APRISASR-MIB-4RF >>_
```

Management Display Panel

The Aprisa SR has an optional Management Display Panel which provides on-site management and diagnostics without the need for PC.

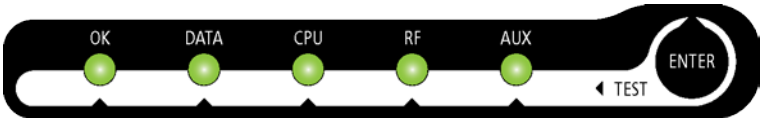
The features include:

- Displaying and changing frequencies
- Enabling and disabling user interfaces
- Displaying alarms
- Displaying performance data
- Performing upgrades
- Performing onsite tests

† Future Product Release

LED Display Panel

The Aprisa SR has an LED Display panel which provides on-site alarms / diagnostics without the need for PC.



Normal Operation

In normal radio operation, the LEDs indicate the following conditions:

	OK	DATA	CPU	RF	AUX
Solid Red				*RF path transmit fail alarm*	
Flashing Red				*Radio not connected to a Base Station*	*Radio uncalibrated alarm*
Solid Orange				*RF path minor alarm*	*Duplicate IP address condition detected in network*
Flashing Orange		*Tx Data or Rx Data on the USB management port*	*Device detect on the USB host port*	*RF path TX is active*	*Copy of Alarm History file to the USB drive is in progress*
Flashing Green		*Tx Data or Rx Data on the serial port*		*RF path RX is active*	
Solid Green	*Power on and functions OK*	*All interface ports are OK*	*Processor Block is OK*	*RF Path is OK*	

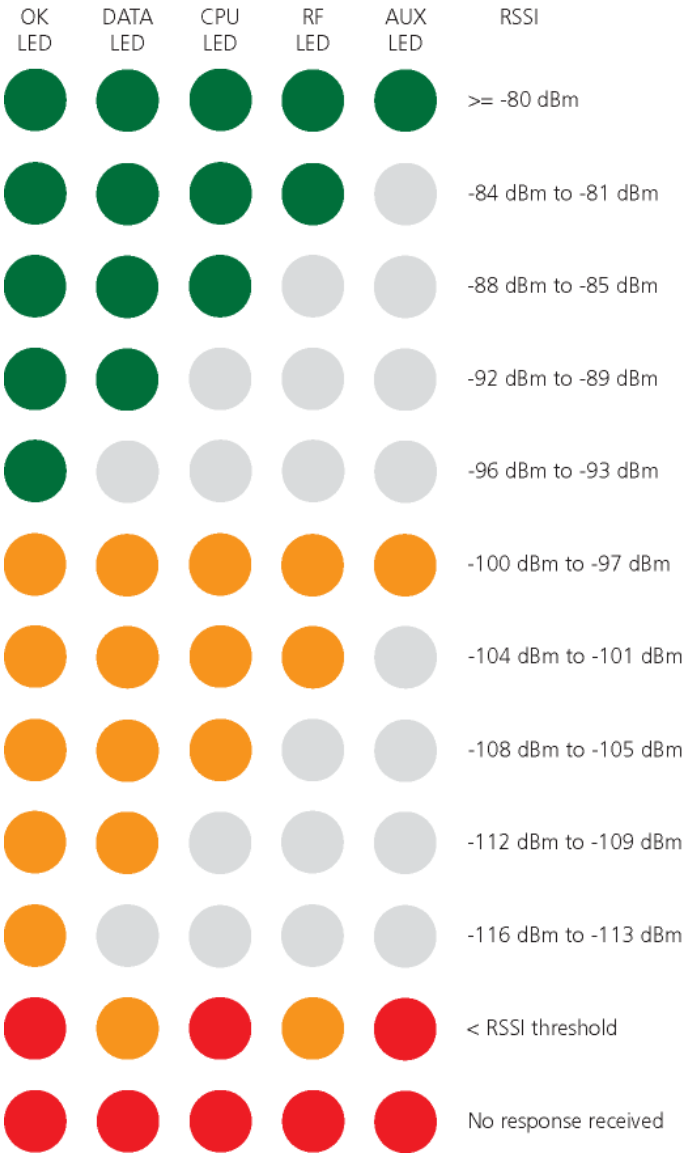
Software Upgrade

During a software upgrade, the LEDs indicate the following conditions:

- Software upgrade started - the OK LED flashes orange
- Software upgrade progress indicated by running AUX to DATA LEDs
- Software upgrade completed successfully - the OK LED solid orange
- Software upgrade failed - any LED flashing red during the upgrade

Test Mode

In Test Mode, the LED Display panel presents a real time visual display of the RSSI. This can be used to adjust the antenna for optimum signal strength.



4. Applications

This section describes sample Aprisa SR radio applications.

The following applications are described:

- Basic point-to-multipoint application
- Advanced point-to-multipoint application with repeaters
- Multi-interface point-to-multipoint application

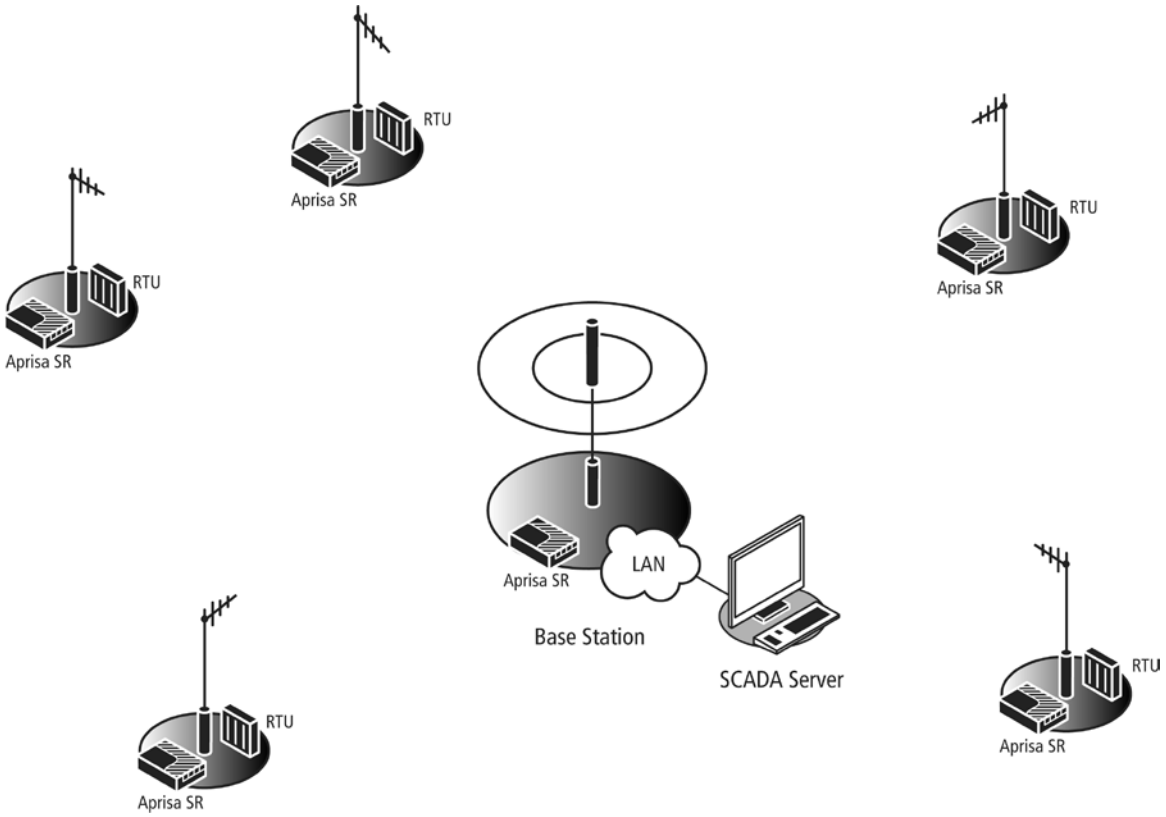
Basic point-to-multipoint application

Single base station with Ethernet SCADA data inputs to multiple geographically remote sites with Ethernet RTUs requiring control and data acquisition.

The base station receives Ethernet frames from the SCADA server LAN and broadcasts all Ethernet frames to all remote stations

Each remote site receives Ethernet frames from the RTU and unicasts over the air to the base station.

The base station uses an omni directional antenna to provide wide coverage and the remote stations are fitted with directional Yagi antennas to provide higher gain.



Advanced point-to-multipoint application with repeater

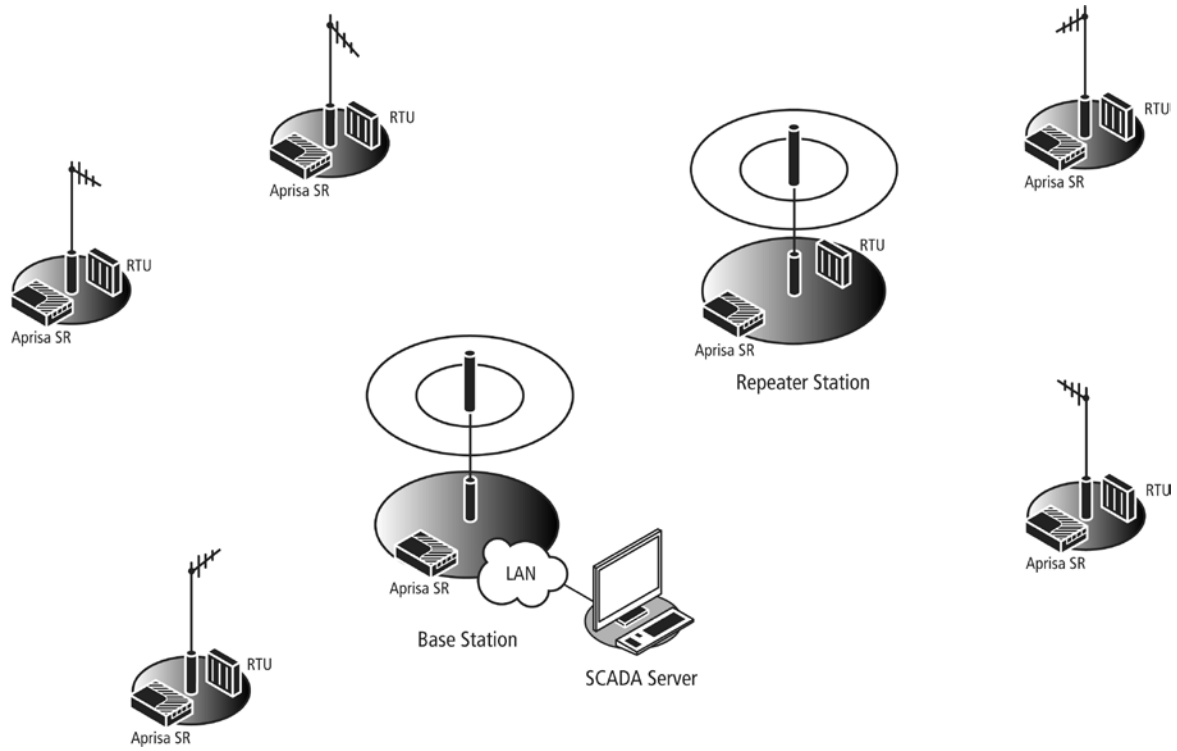
Single base station with Ethernet SCADA data inputs to multiple geographically remote sites with Ethernet RTUs requiring control and data acquisition. A repeater is deployed to service remote sites beyond the reach of the base station.

The base station receives Ethernet frames from the SCADA server LAN and broadcasts all Ethernet frames to the repeater and its remote stations.

Three remote sites have direct radio communication with the base station but the other two remote sites operate via the repeater site.

Each remote site receives Ethernet frames from the RTU and unicasts over the air to the repeater / base station.

The base station and the repeater station use an omni directional antenna to provide wide coverage and the remote stations are fitted with directional Yagi antennas to provide higher gain.



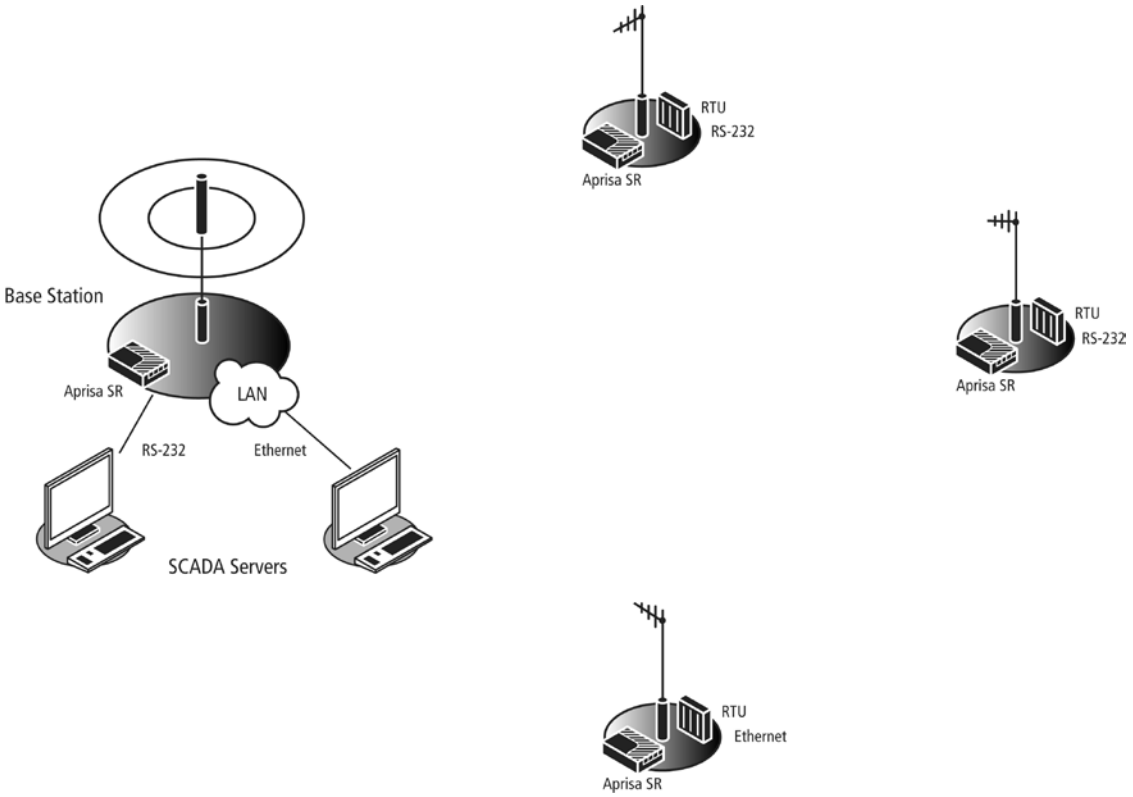
Multi-interface point-to-multipoint application

Single base station with Ethernet and RS-232 SCADA data inputs to multiple geographically remote sites with Ethernet and RS-232 RTUs requiring control and data acquisition.

The base station receives Ethernet / RS-232 frames from the SCADA servers and broadcasts all frames to all remote stations

Each remote site receives Ethernet / RS-232 frames from the RTU and unicasts over the air to the base station.

The base station uses an omni directional antenna to provide wide coverage and the remote stations are fitted with directional Yagi antennas to provide higher gain.

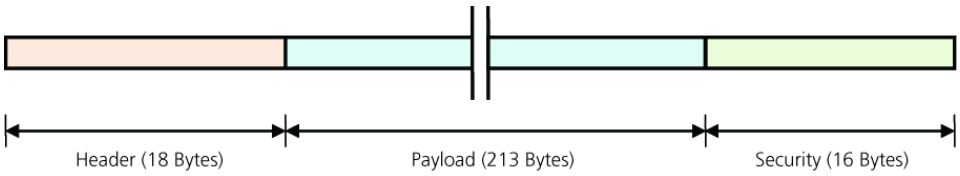


5. Architecture

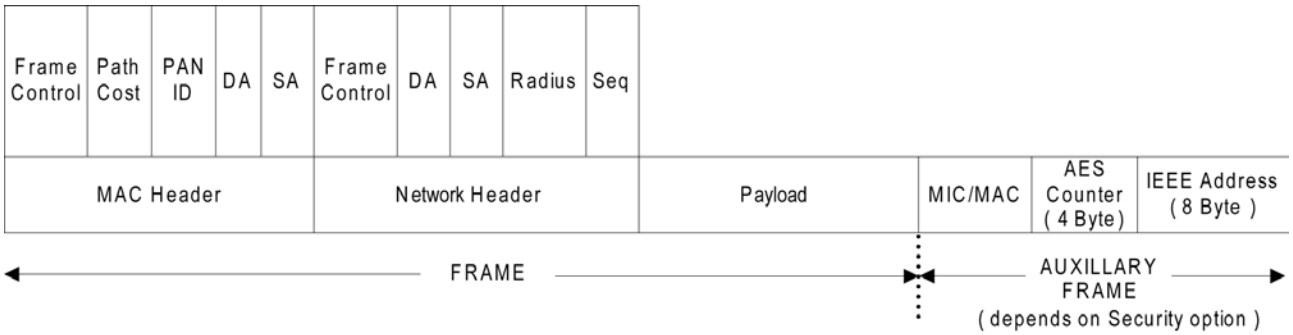
Product Description

There are three components to the wireless interface: the Physical Layer (PHY), the Data Link Layer (DLL) and the Network Layer. These three layers are required to transport data across the wireless channel in the Point-to-Multipoint (PMP) configuration. The Aprisa SR DLL is largely based on the 802.15.4 MAC layer using a proprietary implementation.

An example wireless protocol frame structure is illustrated below. This uses maximum security of 16 Bytes. The length of the header varies depending on whether the user data must be segmented. User data will be segmented if it is larger than the wireless packet payload length. In this case, this limit is 213 Bytes. If the user data packet is larger than this, then the header increases to 20 Bytes to account for the transport of the required segmentation and reassembly data.



This frame structure consists of:



Frame

MAC Header

Frame Control

The frame control field is used to maintain coexistence with IEEE 802.15.4 and ZigBee standards.

Path Cost

This field is used only during route discovery, but is present in all data frames.

FAN ID

The FAN ID may be any value between 0x0001 and 0x7fff, and represents the FAN.

DA

The Destination Address field defines the destination of the next hop, or 0xffff for broadcasts.

SA

The Source Address field defines the source of this hop.

Network Header

Frame Control

The frame control field at the Network Header allows the Daintree SNA to interpret the fields correctly. In addition, the 'discover route' field, in bits 6-7 determines if a unibroadcast should discover a route. Bit 15 is used to indicate an ACK is requested.

DA

The Destination Address field in the Network Header defines the ultimate destination (not current hop).

SA

The Source Address field in the Network Header defines the original source (not current hop).

Radius

The Radius field is decremented each hop until it reaches 0.

Seq

The sequence number uniquely identifies the packet.

Payload

Based on the security configuration, the payload could be either encrypted or un-encrypted.

Auxillary Frame

The Auxillary Frame fields are dependant on the security configuration chosen.

MIC/MAC

A 0-16 byte register for the Message Authentication Code.

AES Counter

A 4 byte counter reuired for encryption.

IEEE Address

An 8 byte IEEE MAC address.

Physical Layer

The Aprisa SR PHY uses a one or two frequency ½ duplex transmission mode which eliminates the need for a duplexer.

Remote nodes are predominantly in receive mode with only sporadic bursts of transmit data. This reduces power consumption.

The Aprisa SR is a packet based radio. Data is sent over the wireless channel in discrete packets / frames, separated in time. The PHY demodulates data within these packets with coherent detection.

The Aprisa SR PHY provides carrier, symbol and frame synchronisation predominantly through the use of preambles. This preamble prefixes all packets sent over the wireless channel which enables fast synchronisation.

Data Link Layer / MAC layer

The Aprisa SR PHY enables multiple users to be able to share a single wireless channel; however a DLL is required to manage data transport. The two key components to the DLL are channel access and hop by hop transmission.

Channel Access

Channel access is realized in the Aprisa SR using Carrier Sense Multiple Access (CSMA). In this mode, a pending transmission requires the channel to be clear. This is determined by monitoring the channel for other signals for a set time prior to transmission. This results in reduced collisions and improved channel capacity.

There are still possibilities for collisions with this technique e.g. if two radios simultaneously determine the channel is clear and transmit at the same time. In this case an acknowledged transaction may be used. The transmitter requests an ACK to ensure that the transmission has been successful. If the transmitter does not receive an ACK, then random backoffs are used to reschedule the next transmission.

There are a number of parameters that can be altered for the channel access such as back off times, number of retries etc. To enable the most efficient use of the channel these parameters will differ for each network (largely dependent on number of radios in the network).

Hop by Hop Transmission

Hop by Hop Transmission is realized in the Aprisa SR by adding a MAC address header to the packet. For 802.15.4, there are 2 addresses, the source and destination addresses.

Network Layer

Packet Routing

Packet routing is realized in the Aprisa SR by adding a network address header to the packet. This contains source and destination addresses. For the Network Layer, there are 2 addresses, the address of the originating radio and the address of the terminating radio (i.e. end to end network). This is required for routing packets across multiple hops e.g. PMP with repeaters.

The Aprisa SR uses an automated method for performing address assignment and routing information.

There are two types of packets: unicast and broadcast. Only the base station sends broadcasts which are received by all remote stations. User packets are not interpreted as the radio link is transparent.

Traffic

Data originating on the Base Station is broadcast to all Repeater Stations and Remote Stations.

Data originating on a Remote Station is unicast to the Base Station only. This can be via multiple Repeater Stations.

Data originating on a Repeater Station is unicast to the Base Station only.

Data originating on a serial port is terminated on a serial port and data originating on an Ethernet port is terminated on an Ethernet port only.

User Traffic

User traffic is prioritized depending on the Serial and Ethernet Data Priority options.

If the Serial and Ethernet Data Priority options are equal, then first come first served is invoked.

Repeater stations repeat traffic also on a first come first served basis.

Management Traffic

Ethernet Management Traffic has the same priority as Ethernet User Traffic but if the radio is not licensed for Ethernet, the Ethernet Data Priority is set to Low.

Product Operation

Carrier Sense Disabled

The following timing diagram illustrates two transactions with Carrier Sense disabled on the Remote Stations.

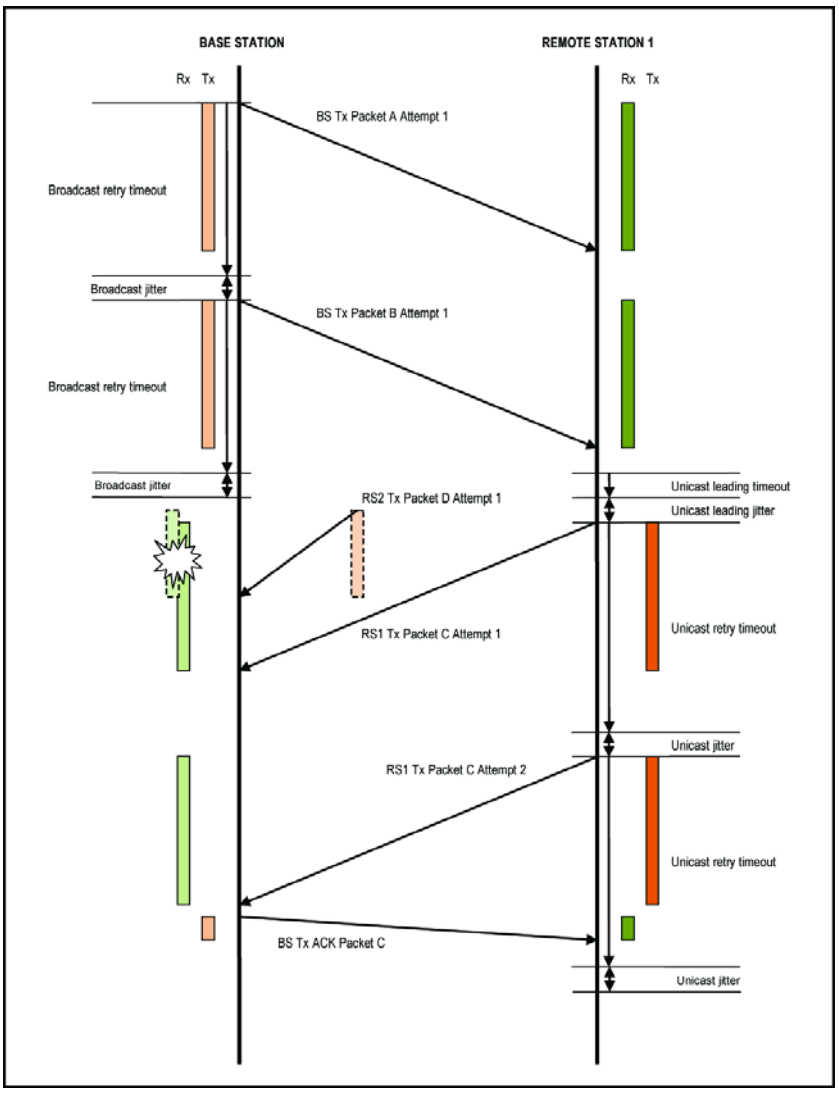
1. The Base Station broadcasts 2 packets to all Remote Stations.

The Base Station uses default settings e.g. 1 attempt. In this example, the 2nd packet (packet B) arrives over the wired interface at the Base Station for transmission over the air before the 1st packet (packet A) has left. The 2nd packet is queued. The timing diagram illustrates that the retry timer is used to schedule the 2nd packet in the same way as a 2nd attempt would be queued.

2. Remote Station 1 attempts to send a packet (packet C) to the Base Station without the use of carrier sense.

In this case, a second Remote Station (Remote Station 2) also attempts to send a packet (packet D) to the Base Station at approximately the same time. In this case the 2 packets collide and the Base Station does not reply with an ACK. The Remote Station unicast retry timer times out and the 2nd attempt is sent. This attempt is successful and an ACK is received.

In this case, channel access is ALOHA.



Carrier Sense Enabled

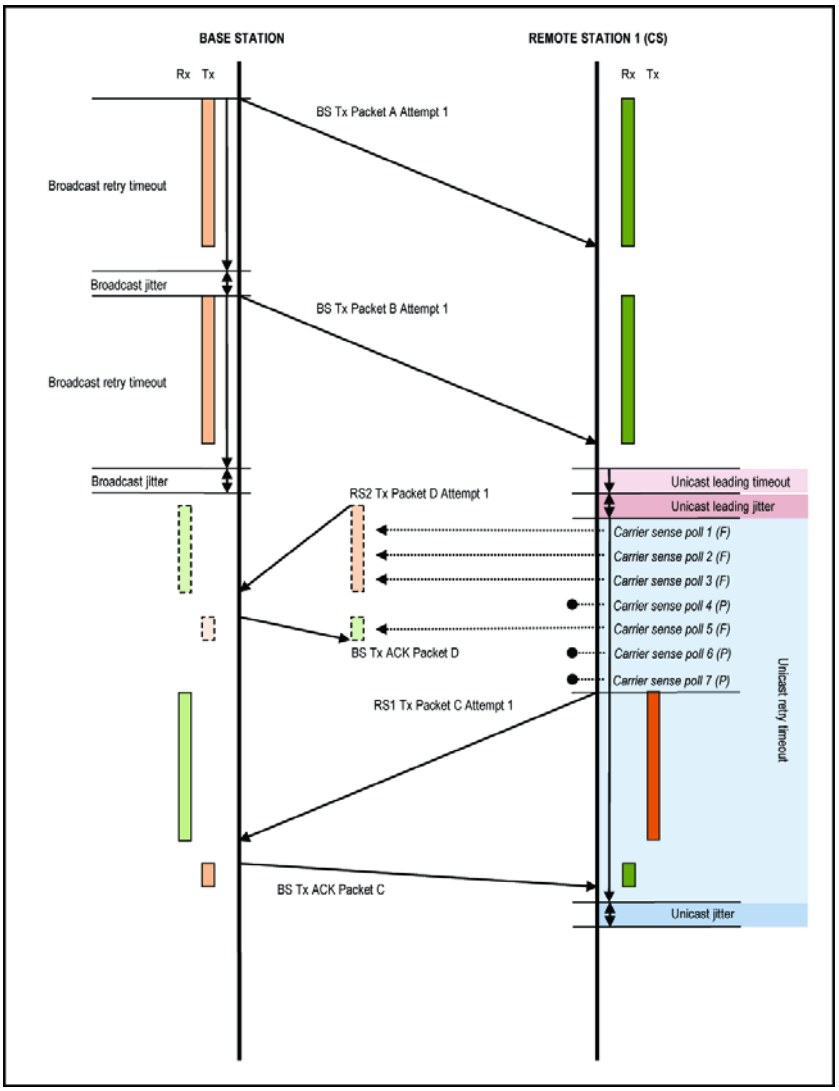
The following timing diagram illustrates the same transactions with Carrier Sense enabled on the Remote Stations. Transmit packets are depicted as orange blocks and received packets are depicted as green blocks.

1. The Base Station broadcasts 2 packets to all Remote Stations.

In this case, the transactions are identical to the previous example.

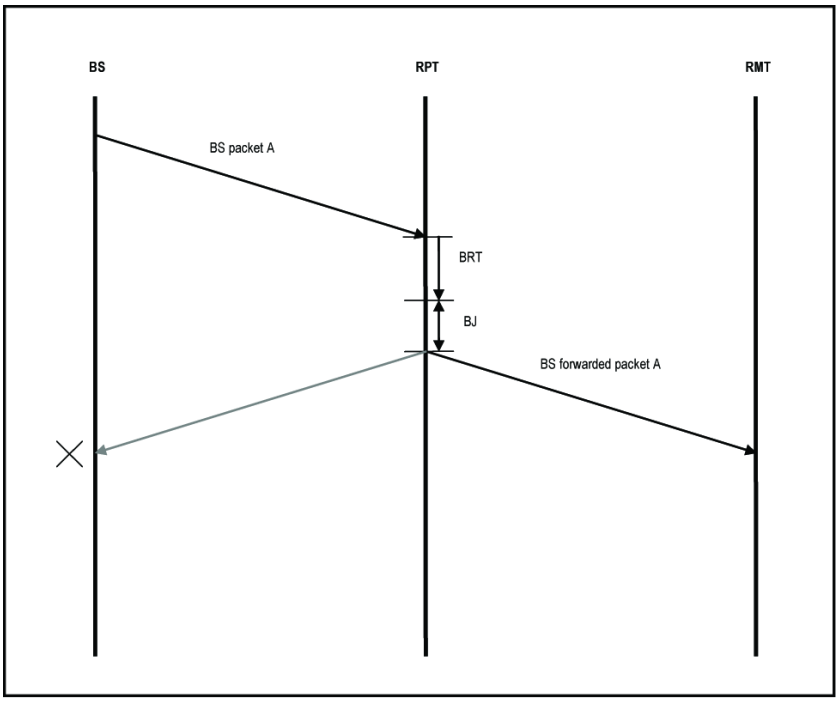
2. Remote Station 1 attempts to send a packet (packet C) to the Base Station with the use of carrier sense.

Here the Remote Station detects that the channel is being used by Remote Station 2. The carrier sense polls the channel and requires 2 consecutive channel clear assessments before the channel is accessed. This enables the carrier sense system to detect a possible ACK. This is illustrated above with one of the carrier sense polls (poll 4) passing as it detects the gap between packet D and its associated ACK.


BASE STATION
REMOTE STATION 1 (CS)
Rx Tx
Rx Tx
BS Tx Packet A Attempt 1
Broadcast retry timeout
Broadcast jitter
BS Tx Packet B Attempt 1
Broadcast retry timeout
Broadcast jitter
Unicast leading timeout
Unicast leading jitter
RS2 Tx Packet D Attempt 1
Carrier sense poll 1 (F)
Carrier sense poll 2 (F)
Carrier sense poll 3 (F)
Carrier sense poll 4 (P)
Carrier sense poll 5 (F)
BS Tx ACK Packet D
Carrier sense poll 6 (P)
Carrier sense poll 7 (P)
RS1 Tx Packet C Attempt 1
Unicast retry timeout
BS Tx ACK Packet C
Unicast jitter

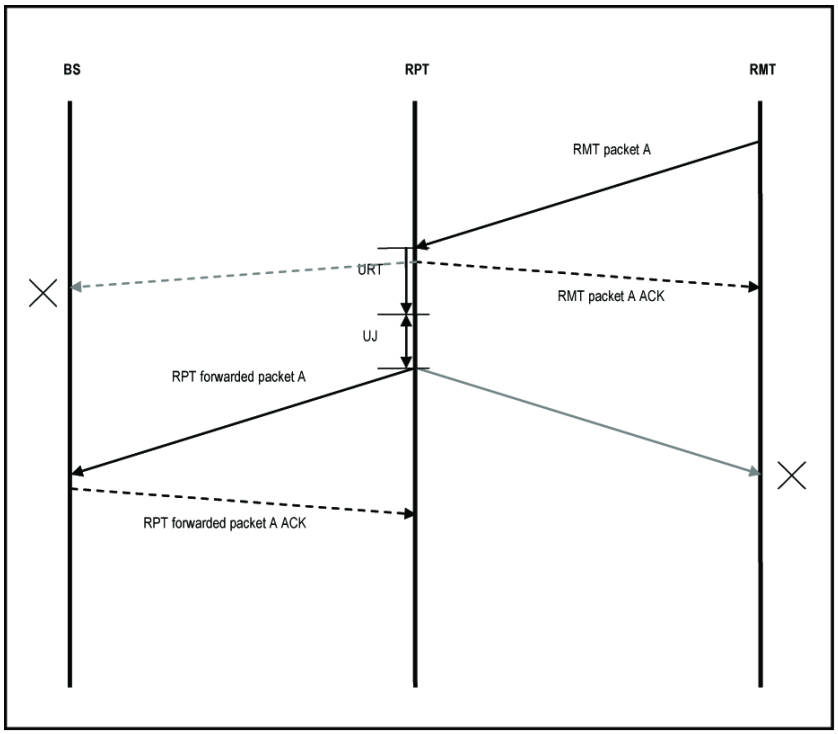
Repeater Timing for Base Station to Remote Station Transactions

The following timing diagram illustrates repeater timing for Base Station to Remote Station transactions. Packets are scheduled by the Broadcast Retry Timeout and Broadcast Jitter parameters.



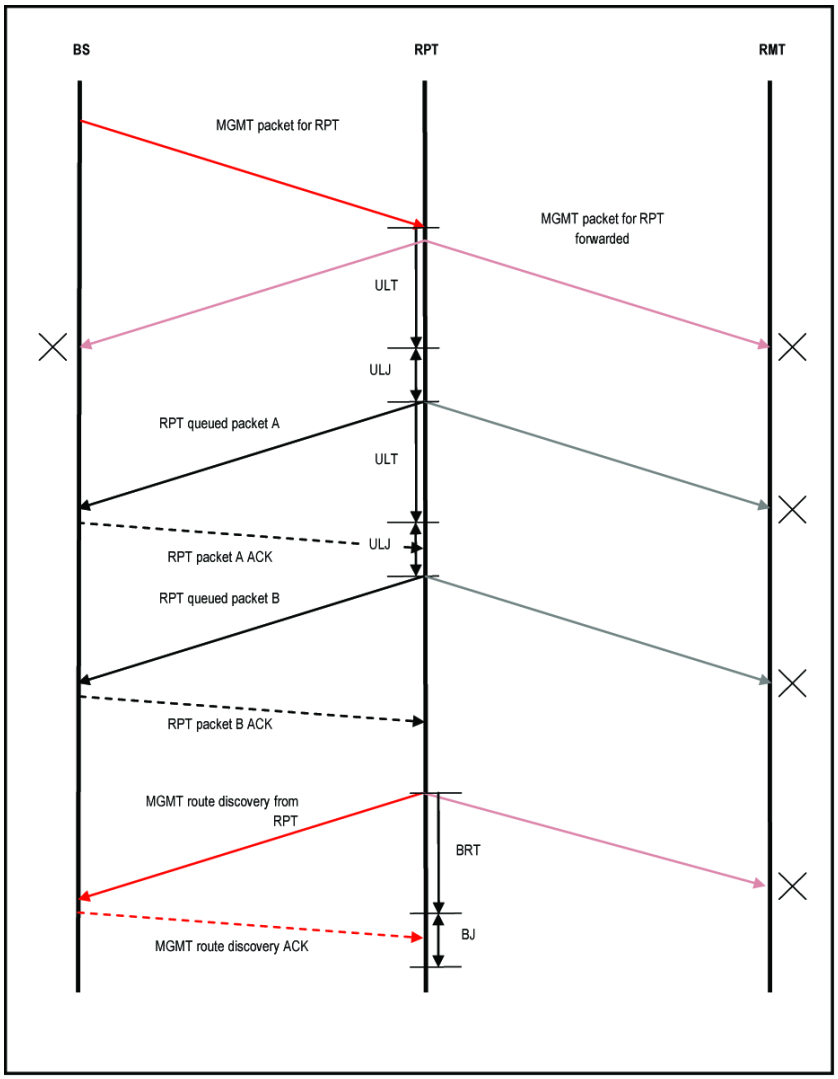
Repeater Timing for Remote Station to Base Station Transactions

The following timing diagram illustrates repeater timing for Remote Station to Base Station transactions. Packets are scheduled by the Unicast Retry Timeout and Unicast Retry Jitter parameters.



Repeater Timing for Queued Packets at the Repeater Station

The following timing diagram illustrates repeater timing for queued packets at the Repeater Station. Packets are scheduled by the Unicast Leading Timeout and Unicast Leading Jitter parameters.



Product Architecture

The following are the key components of the Aprisa SR design:

High performance ΣΔ fractional-N synthesizer

- 2x output frequency VCO for minimal pulling during transmit
- Wideband design electronically tunes over entire band
- Tx and Rx LO operate on the same frequency, reducing the tuning range of the VCO and therefore better noise performance
- Proven ultra low noise technology – 50dB SNR easily achieved

Direct IQ modulation

- Simple IQ modulation line up reduces part count and improves MTBF
- No mixing stages so no spurious responses present at the transmitter output

Tx turn-on time limited primarily by PA ramping

- Robust, closed-loop power control – fast, accurate power ramp up and down

MOSFET PA device

- High efficiency (>60% PAE at 8W)
- Very low thermal resistance (2.5°C/W)

Direct IQ down-conversion

- Excellent Intermodulation distortion characteristics as channel filter can be placed directly after the mixer without impacting noise figure
- High Q active channel filtering helps achieve selectivity performance
- Low parts count and no crystal filters help to keep receiver performance extremely stable over temperature

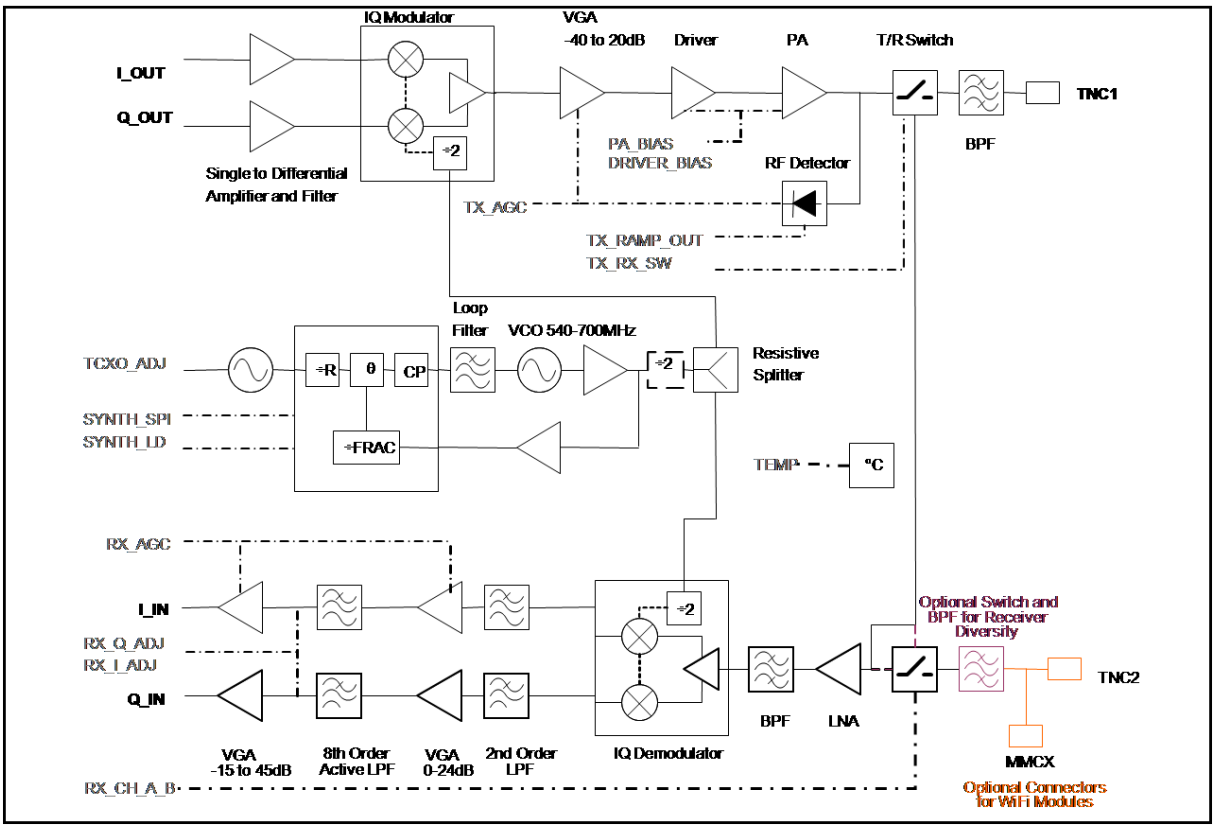
Integrated heat sink

- Limits number of mechanical interfaces
- Fin design optimized for natural convection

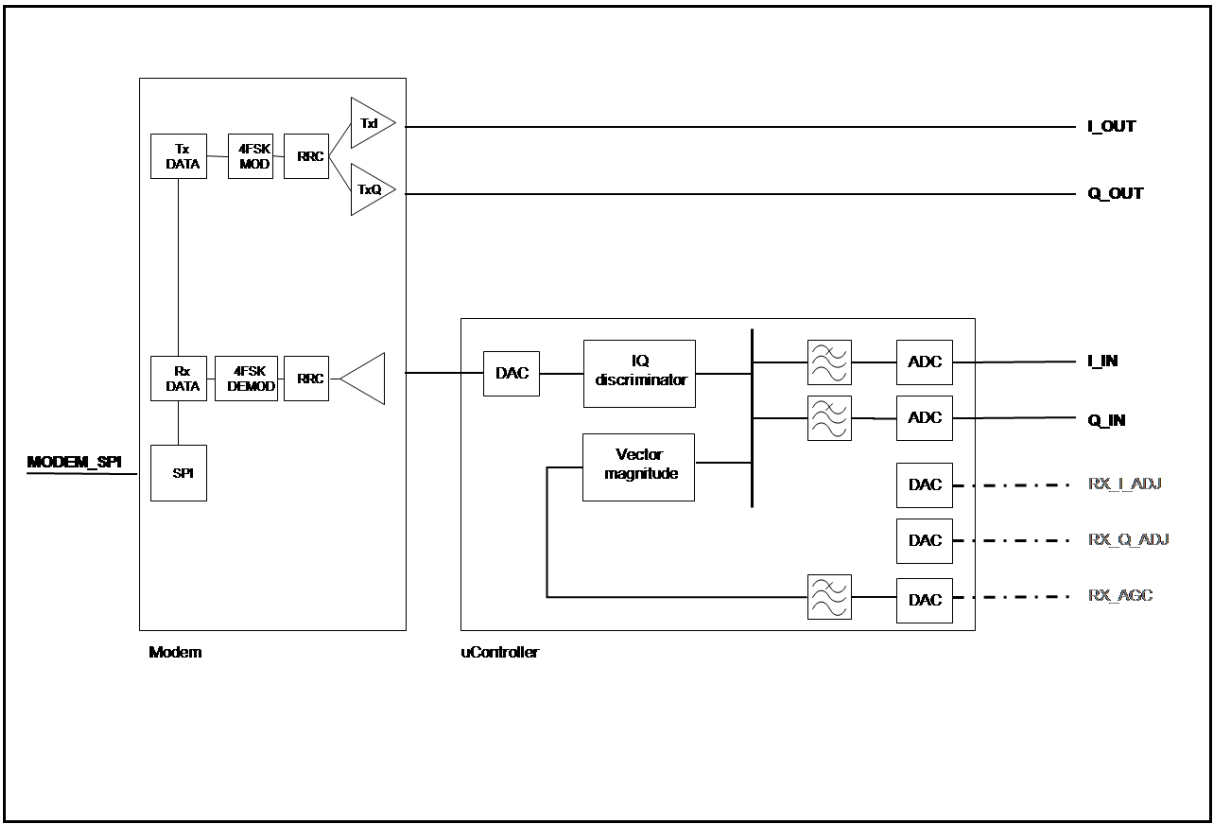
Monitoring and software control

- Temperature control loop shuts down transmitter when the temperature exceeds continuous operation at 70°C
- Monitoring of RSSI and PA current help to make sure the RF hardware is functioning to specification

Radio Block Diagram



Modem Block Diagram



6. Contact Us

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